REMARKS

Applicant considered the Office Action mailed on October 22, 2003, and the references cited therewith. This response cancels claims 32 and 42 without prejudice, amends claims 2, 33-34, 37, and 43-44, and adds new claims 45-55. As a result, claims 2-8, 33-41, and 43-55 remain pending in the Application.

§112 Rejections of the Claims

Claims 2-8 and 32-44 were rejected under 35 USC §112, first paragraph, as failing to comply with the written description requirement. Applicant respectfully traverses these rejections.

When Applicant employs the word "seamless," it is abundantly clear that she means it in an optical sense, and this sense was apparently understood through three Office actions dealing with claims that included this term. For example, the two terms "seamlessly" and "without visible seam" are equated as synonyms[1] at page 6 lines 17-22 of the Specification. Nevertheless, claims 2 and 37 are amended so as to recite explicitly that the tiling is without a "visible" seam. It is of course impossible to show directly in Fig. 7 a seam which is invisible. However, the description of Fig. 7 at page 6 lines 23-28 clearly says that it is "seamlessly tiled" (line27). And, in any case, Fig. 6 explicitly indicates multiple seamlessly tiled faceplates 10, described in the Specification at page5 lines 10-20. Note especially the plural reference to "faceplates 10" in line 20.

Because the amendments to claims 2 and 37 merely replace one term with another equivalent term, they do not narrow the scope of the claims.

New claims 45-56 do not include recitations to seams or their absence, and thus entirely avoid any grounds for rejection under 35 USC §112.

§103 Rejections of the Claims

Claims 2-8, 32-38 and 42-44 were rejected under 35 USC §103(a) as being unpatentable over Sakai et al. (U.S. 5,502,457) in view of *Adventures in Fiber Optics Kit* by Industrial Fiber

---

[1] ---It is well settled that an applicant may be his own lexicographer, and may employ terms that modify a dictionary definition, as long as their use does not contravene a meaning that is standard in the applicable technology.

AMENDMENT AND RESPONSE UNDER 37 CFR § 1.111

Page 7

Serial Number: 09/751357

Dkt: 256.063US1

Filing Date: December 29, 2000

Title: SEAMLESS REAR PROJECTION SCREEN

Optics, Inc. (AFOK) Applicant respectfully traverses these rejections. Applicant's previous responses have adduced reasons that the claims distinguish the references. This response is accordingly limited to the points raised in paragraphs 7-12 of the Office Action.

Paragraph 7 states that "the examiner doesn't use Sakai's reference to overcome said limitation" to fibrous crystalline material. However, the rejection under 35 USC §103 is based upon a combination of the Sakai reference with the AFOK reference. Therefore, 35 USC §103 requires that Sakai must provide some internal motivation for using other than the conventional glass fibers that he shows. Applicant has discovered a novel property of certain materials, a lack of "dead fibers" (see page 3 lines 1-3) at the edges that allows these materials to be tiled (optically) seamlessly very easily and cheaply, whereas conventional fibers such as Sakai proposes requires special techniques for multiple use. Thus, the rejection has impermissibly combined Sakai and AFOK only in light of Applicant's disclosure.

Applicant does not understand how AFOK suggests any combination whatsoever of individual faceplates with each other. The statement in paragraph 8 of the Office Action only speaks of and shows individual faceplates. The only motivation for tiling such individual faceplates spring from Applicant's inventive recognition that these materials, unlike other optical materials, do not have dead fibers at the edge that produce optically objectionable joints or seams. AFOK certainly contains no hint of Applicant's insight, and thus has no motivation for tiling multiple individual faceplates.

As to the "scale of nanometers" in paragraph 9, Applicant reiterates the common understanding that this phrase would not be taken by anyone in the art to refer to tens of thousands of nanometers. In addition, however, the Specification provides a basis for quantifying this term more closely. Page 6 lines 18-20 equates this scale to the size of the optical channels in the material: "A faceplate made of fibrous crystal in accordance with the present invention would have a pitch or fiber size on a scale of nanometers and therefore would produce no visible seam." This quantity is known in the art. For example, the attached copy of Ikhuhara et al., *Microstructure characterization of one-directionally oriented ulexite,* J. Mater. Res. vol. 43 no. 3 (Mar. 1998), pp. 778-783 states on page 779 col. 2 that "average grain size of the

bundles is several tenths μm." That is, several hundred nanometers.[2]. This is smaller by two orders of magnitude than the 30,000nm in the reference.

As to paragraph 10, the fact that "Ulexite … may one day be refined and used commercially" does not say or suggest---except in the knowledge of Applicant's disclosure--- that it can be manufactured in a laboratory. "Refining" a mineral or an ore denotes purifying it from a natural state, and does not imply "producing" it from its constituents in a laboratory or manufacturing facility. Certainly AFOK suggests no advantage of a synthetic version. Applicant, in contrast, proposes several advantages of a lab-grown version in some environments; see page 6 lines 5-17 of the Specification, for example. Thus, AFOK bare statement that sometime in the indefinite future someone might possibly find some unspecified use for a purified form of the natural mineral, does not amount to a motivation to synthesize it from its constituents.

See new claim 48 in connection with paragraph 10.

The comments in paragraph 12 appear moot, because this Office Action does not reject any claims on the previously cited Bilbro reference. The only rejections under 35 USC §103 appear to be claims 2-8, 32-38, and 42-44 as to Sakai and AFOK, in paragraph 4 of the Office Action. However, the reasoning in paragraph 12 is specious in any event. Claim 37 recites the "image source" from the "first diffusing assembly" as separate elements. If Applicant's "light source" is read on the combination of Sakai's light source and his fiber bundles, then Sakai has no other distinct element that can be applied to Applicant's "first diffusing assembly" with its tiled crystals.

New Claims

New independent claims 45 and 53 do not include seamless tiling. Therefore, they escape any rejection of claims 2 or 37 under the first paragraph of 35 USC §112. Further, as demonstrated above and in previous responses, claim 2 distinguishes the cited references any valid combination thereof without recourse to seamlessness of the tiling.

---

[2] ---Additional support for this range of values lies in the lasrt part of the passage quoted from the Specification. The lack of visible seam arises from the fact that the fiber size is commeasurable with the wavelengths of visible light. One skilled in the optical arts would be expected to know this.

Dependent claims 46-52 and 54-55 incorporate the features of their parents, and distinguish the references as well. In particular, claim 49 specifies that the optical faceplate is "doped so as to change its optical properties," the advantages of which are described on page 6 lines 5-12 of the Application. Sakai mentions Ulexite not at all, and AFOK suggests no doping of the natural crystal material, nor any conceivable reason for doing so. As other examples, claims 50-52 recite other modifications to synthetic crystals, modifications that are not found in nature. Page 5 lines 12-14 discusses these modifications. None of them are even remotely suggested in the cited references.

Dependent claim 47 omits Ulexite from the claimed group of "Selenite, Artinite and Aragonite," and thus avoids any materials shown in or suggested by the cited references. Dependent claim 55 recites that the fibrous crystal has a pitch "less than that of glass." Glass, of course, is the material employed by Sakai, and Sakai has no suggestion of or motivation for, using a material with a smaller pitch.

Conclusion

For the above and other reasons, Applicant urges that the Application meets all statutory requirements, and respectfully requests reexamination under 35 USC §132 and allowance of the claims. The Examiner is invited to telephone Applicant's attorney at (612) 373-6971 if deemed desirable to facilitate prosecution of this Application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.
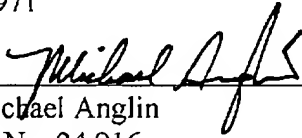
Respectfully submitted,

ALEKSANDRA KOLOSOVSKY

By her Representatives,

SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
P.O. Box 2938
Minneapolis, MN 55402
(612) 373-6971

Date 22 Jan 2004   By _____
                             J. Michael Anglin
                             Reg. No. 24,916

CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 22 day of January, 2004.

Gina M. Uphus   _____

Name   Signature

Microstructure characterization of one-directionally riented ulexite

Yumi H. Ikuhara and Shinji Kondoh
Synergy Ceramics Laboratory, Fine Ceramics Research Association, 2-4-1 Mutsno, Atsuta-ku, Nagoya 456, Japan

Koichi Kikuta
National Industrial Research Institute of Nagoya, 1 Hirate-cho, Kita-ku, Nagoya 462, Japan

Shin-ichi Hirano
Department of Applied Chemistry, School of Engineering, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-01, Japan

Microstructures of ulexite were investigated by CTEM and low electron dose HREM. It was found that the longitudinal grains in ulexite were oriented to c-direction to form a bundle structure. There were a number of small-angle grain boundaries and stacking faults inside a grain in the ulexite. Cleavage microcracks and stacking faults were mostly introduced on the {010} of the ulexite. The high-angle grain boundaries mainly consisted of high coincidence boundaries, which was confirmed by a comparison of observed contact angles and calculated degree of coincidence at the boundaries. The light transmittance properties of the ulexite would depend on the defects such as stacking fault, small-angle grain boundary, and high-angle grain boundary.

INTRODUCTION

As the media of light transmission, optical fibers we been intensively studied for several decades.[1-4] The tical fibers are usually amorphous and consist of the aracteristic microstructure such as clad and core with different refractive indices. On the other hand, ulexite scovered in nature has a unique optical property as the dia of light transmission. Ulexite transmits the light ing an oriented direction, and thus is called "television ne." Ulexite has an optically biaxial positive crystal d has refractive indices $\alpha = 1.49$, $\beta = 1.504$, and = 1.520.[5] If the refractive indices of the neighboring er are α and γ, the boundary of the fiber is separated the high and low index region, thus the high index ine of the fiber behaves as the clad compared to the v index plane of the neighboring fiber.[6] Therefore, one ngated crystal of ulexite has a function as an optical er. The light traveling from one side of the elongated ection of the bundle transmits through the crystal to opposite side, repeatedly the total reflection at the undary of the crystals with different refractive indices. Ulexite has a triclinic structure ($a = 8.809$ Å, = 12.86 Å, $c = 6.678$ Å, $\alpha = 90.15°$, $\beta = 109.07°$, l $\gamma = 105.06°$), and the oriented microstructure of the dle is parallel to the c-axis. Its transmittance property ends on the microstructure such as grain boundary I stacking fault inside the crystal. The crystal structure ulexite has been identified using x-ray diffraction lysis[5,7-9]; however, XRD technique pr vides only average structures in the materials. In order to have a full understanding of the properties, another technique is needed to observe local structures such as lattice defects.

High resolution electron microscopy (HREM) is one of the most effective methods for characterizing local microstructures with an atomic scale. However, no attempt has been made to characterize ulexite by HREM and even by conventional TEM (CTEM). This is because the ulexite is too unstable to observe under the electron beam irradiation.[10] The chemical composition of ulexite is $NaCaB_5O_6(OH)_6 \cdot 5H_2O$,[11,12] and thus, the combined water is included inside the structure. The existence of the water does not enable us to observe an image under ordinary conditions of CTEM and HREM observations (beam current density >10 A/cm^2).

In this study, we used mainly a technique of low electron does HREM to characterize the microstructure of ulexite. In addition to HREM, selected-area diffraction patterns (SADP's) and CTEM were utilized to investigate the grain structure such as crystal orientation, grain boundaries, and stacking faults in ulexite. Grain boundary characteristics are discussed on the basis of the observed results.

II. EXPERIMENTAL PROCEDURE

The ulexite sample analyzed in this study was obtained from California. First, x-ray powder diffraction analysis was carried out to confirm the crystal structure of ulexite using a Rint2000 (Rigaku Co. Ltd.) x-ray

fractometer with Cu K_α radiation. Next, the phology of the ulexite was observed with the ectron microscope (S-800, Hitachi Co. Ltd.) evaluate the grain size and distribution.

pecimens were prepared using standard tech- lving mechanical grinding to a thickness of npling to a thickness of 20 μm, and ion beam electron transparency at 3–4 kV. The ion ig (Dual Ion Mill Model 600, Gatan Co. Ltd.) sing a cold stage cooled by liquid N_2 to avoid the specimens. The sample was subsequently :d by a JEM4000FX (JEOL Co. Ltd.) electron operated at 400 KeV. HREM observations med to minimize the electron dose using high lm. The electron dose used for the present lies was less than about 0.05 A/cm^2, which :d to <1/200 of that for the ordinary HREM .s. Thus, the direct magnification was as small), and the exposure time was as long as 5–7 s.

SADP's were also taken at an electron dose .05 A/cm^2. Both the TEM and SEM obser- re performed with the incident beam parallel dicular to the c-axis of the ulexite crystal.

.TS AND DISCUSSION

I shows the x-ray diffraction pattern of the shed to powder. All diffraction peaks can be / the diffraction indices calculated from the icture of ulexite with $P\bar{1}$ space group and Å, $b = 12.86$ Å, $c = 6.678$ Å, $\alpha = 90.15°$, 7°, and $\gamma = 105.06$. The strong peak at $2\theta =$

7.24° corresponds to the b-plane with the interplanar distance of $d = 1.22$ nm.

Figure 2 shows a SEM micrograph of the surface of ulexite. The surface of the specimen is perpendicular to the oriented structure which is parallel to the transparent direction. As seen in the figure, ulexite is composed of fiber bundles parallel to the c-direction, and the average grain size of the bundles is several tenths μm.[a] The white contrast in each grain corresponds to microcracks inside a grain. The direction of the microcracks in one grain is approximately aligned in parallel, which suggests the {010} cleavage plane of ulexite.[5] Each grain contacts with the neighbor grains at some specific contact angles, which will be discussed in detail later.

The chemical analysis in a grain and near grain boundary was done by energy dispersed x-ray spectroscopy (EDS). It was found that the composition was uniform and there were no precipitates in the grain boundaries.

Figure 3 shows SADP's taken from the (a) (001) zone axis and (b) (010) zone axis. In Fig. 3(a), the streak can be observed along the [010] direction, which suggests the formation of stacking faults on the (010) planes.

Figure 4 shows a (a) HREM image observed along the [001] direction, and (b) the filtered image of (a). The filtered image was obtained by Fast Fourier Transformation (FFT) of the original image in a computer. The lattice images of (100) and (010) are clearly observed in the figures. The interplanar spacings and angles are consistent with triclinic structure of ulexite projected along the c-direction.

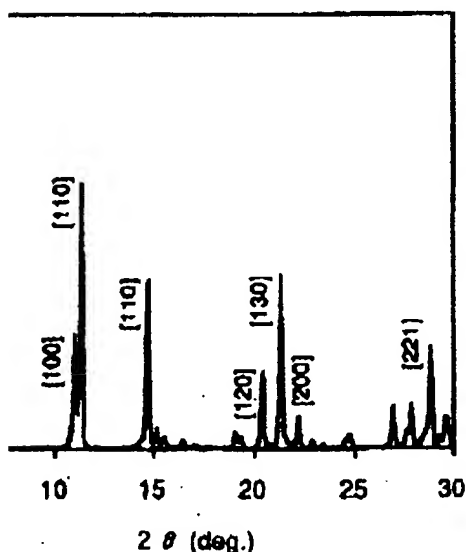Figure 5 shows a bright-field TEM image and SADP's observed nearly along the [001] direction of

-ray diffraction pattern from the crushed ulexite powder.

FIG. 2. Scanning electron micrographs on the surface of ulexite observed from the vertical direction along the oriented fibers. White contrast indicates the microcracks along the grain boundary.
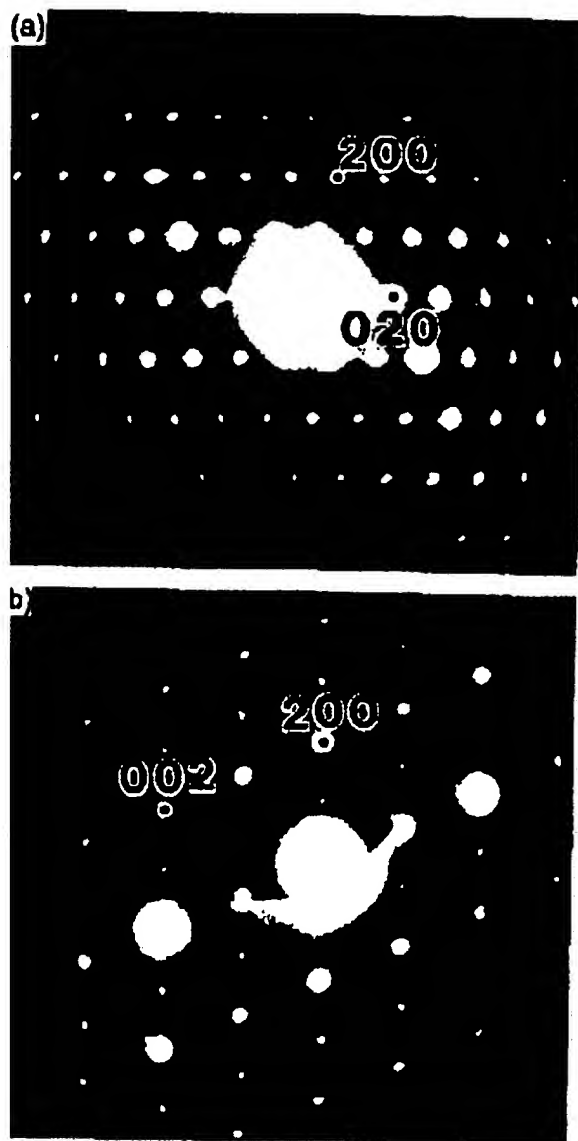
(a)

200

020

(b)

200

002

G. 3. SAD patterns taken from the (a) (001) zone axis and (b) (010)
ne axis.

(a)

0.80 nm

100

010

1.22 nm

(b)

010

100

FIG. 4. (a) HREM image of the ulexite grain and (b) FFT filtered
image of (a).

exite. The SADP's of 1-6 were taken from the 0.5 μm
area of the same number in the TEM micrograph. The
set represents the diffraction pattern of 1. Each SADP
set so as to take orientation to the TEM micrograph. It
thus found that the microcracks are introduced parallel
the (010) planes. This is consistent with the results
Murdoch that the cleavage plane of ulexite is a (010)
ane.[5] The large interplanar spacing of 1.22 nm might
the reason for the cleavage property of (010) planes.
echanical polishing   f the sample is considered to
nduce a number of microcracks along the cleavage

planes inside the crystal. Figure 5 also reveals that the
individual bundle consists of a single crystal, which was
not known for a long time.[13] According to the diffraction
patterns of 1-3, the grain boundaries between grains 1
and 2, 2 and 3 are found to be small-angle tilt grain
boundaries with a misorientation of 3°. Similarly from
the diffraction pattern of 4 and 5, the grain boundary
between grains 4 and 5 is a small-angle tilt boundary.

FIG. 5. CTEM bright-field micrograph of ulexite. The diffraction patterns have been obtained from the pointed area.

laries of grains 3 and 4, 5 and 6 are large-
daries with the misorientation of 30° and 41°.
y. These large-angle boundaries correspond
ridual grain, as shown in Fig. 2.
EM image of a small-angle grain boundary is
ig. 6. This image was taken with the incident
llel to the [001] direction, and the (100) planes
iin can be observed. The misorientation of the
es across the grain boundary is 11°. Misfit
with the Burgers vector perpendicular to the
ild be introduced at the boundary, although
ations cannot be observed because of the lack
quality. The presence of a number of small-
n boundaries is one of the characteristics of

pected from the streak along the (010) direc-
\DP, another characteristic of ulexite is the
of lots of stacking faults on the (010) planes, as
ig. 7. Figure 8(a) is a HREM micrograph and
FFT image observed along the [001] direction,
the high density of stacking faults on the (010)
ice the interplanar spacing of {010} planes is
ting fault energy is considered to be relatively
is, it is concluded that the small-angle grain
and stacking fault in one bundle grain would
optical properties of ulexite. These defects may
as to reduce the total reflection rate, resulting
rease in transparency in the ulexite.
ming the high-angle boundary, the distribu-
sorientation angles can be measured by SEM
hs, as shown in Fig. 2. There is a tendency for
le angle (30, 45, 53, 73, 105°) at the interface
iin boundary, as shown in Fig. 9(a). These

preferable misorientation angles[14] may be coming from
the grain boundary relationship because of the atomistic
scale matching of the grain boundary usually decreases
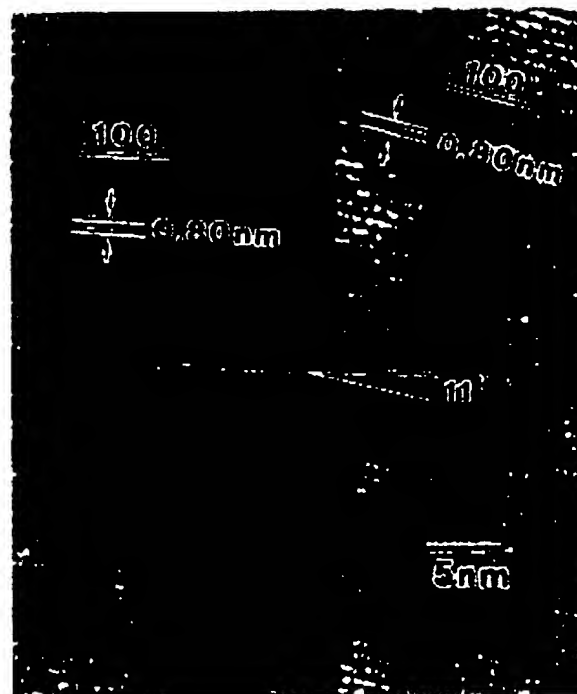the grain boundary energy even in the high-angle grain

FIG. 6. Lattice image of a small-angle grain boundary. Both sides of
planes are parallel to the (100) plane. The misorientation of the (100)
planes across the grain boundary is 11°

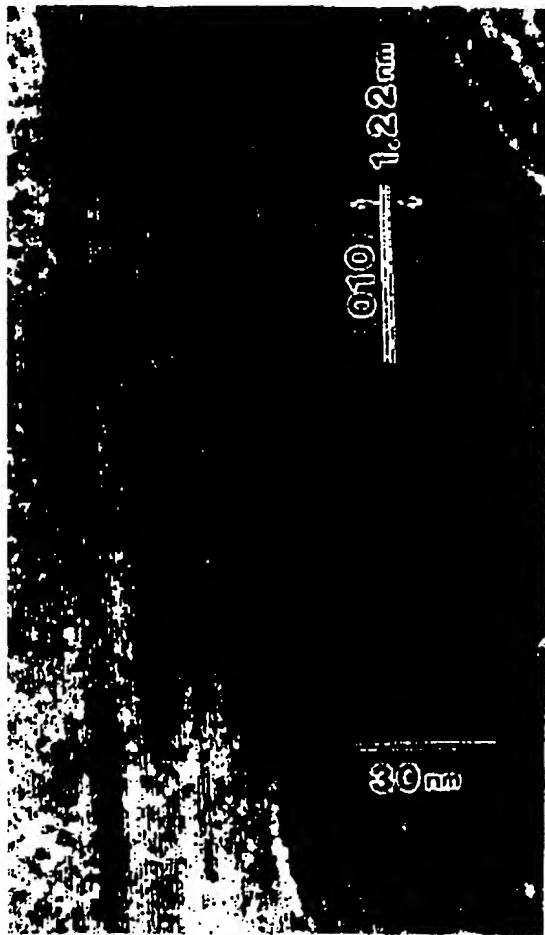7. CTEM micrograph of the stacking faults along the {010} a in ulexite.

FIG. 8. (a) HREM image and (b) FFT filtered image of the stacking faults along the {010} planes in ulexite.

ndary. Thus, the degree of coincidence of atomistic l at the grain boundary was calculated as mentioned w, and was compared with the results from the ostructure measurement.

When two sheets of circle plane consisting of 2000 :e points of the projected unit cell of ulexite super-)se and one of the two rotates around the axis endicular to the lattice plane. many lattice points of planes can superimpose on each other, depending on rotation.[15,16] For instance, we assume that constant me of the sphere lies at the lattice point and the c rotates 1° of steps. Each sphere in the two planes laps at the certain rotated angle. The degree of cidence is calculated as the integrated overlapping me of spheres at all lattice points. Figure 9(b) shows ilated results of the degrees of coincidence at the face of the grains as a function of the rotation angle. s of the coincidence of the lattice are around 45°.
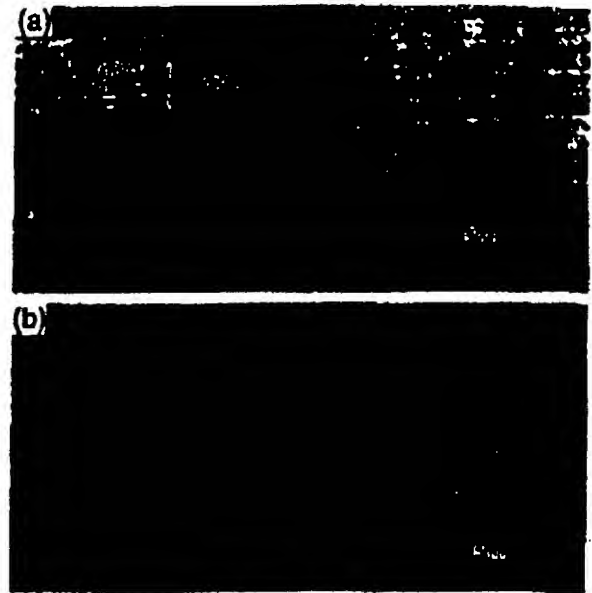
75°, 105°, and 135°, which is in good agreement with the distribution results of the microstructure observation as shown in Fig. 9(a). This result indicates that the two grains contact with the preferable plane of high matching probability. Murdoch reported the ulexite crystal is randomly aligned along the c-axis.[5] Since there are plenty of planes that have a high degree of coincidence of the lattice for ulexite as shown in Fig. 9(b), the interface of the two grains seems to be a randomly contacted. In this research, controversially, we have found that there is a preferential misorientation angle at the interface of the two grains.

In Fig. 9, each grain adjoins at the grain boundary with high degree of coincidence. These orientation relationships at the grain boundary affect the overall light transmission of each fiber because the light transmission of an individual fiber is influenced by the number of rays reflected at the grain boundary. Thus, comparing to the random orientated grain boundary, the grain boundary with a high degree of coincidence could strongly affect the transmission of fiber.

Furthermore, since there are many preferential misorientation angles at the interface of grains in ulexite, each grain could keep from the grain growth because they maintain the interfacial energy as low as possible to form the certain angle. Therefore, the high degree values of coincidence in the several misorientation angles at the grain boundary as shown in Fig. 9(b) result in the promotion of formation of the small fiber bundle along
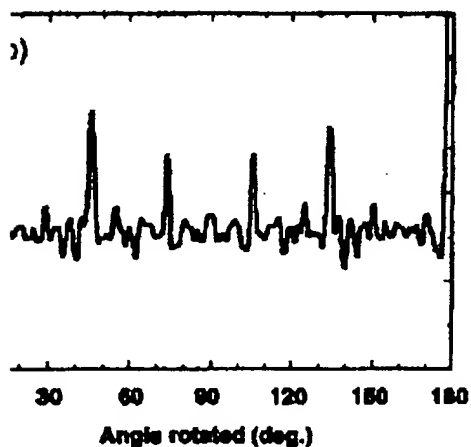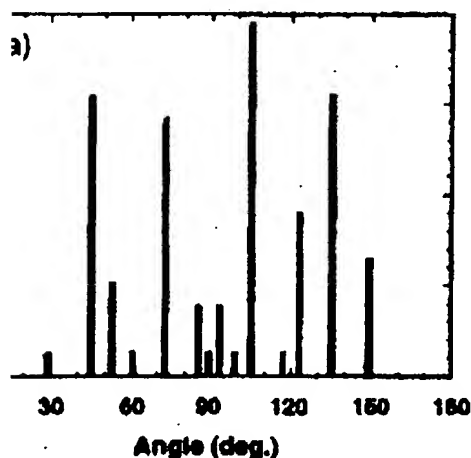
a)

Angle (deg.)

b)

Angle rotated (deg.)

istribution of misorientation angles measured in SEM
d (b) computed relation between the degree of coinci-
rotation angle.

rection to decrease the interfacial energy, as
ig. 2.

.USION

ructures of ulexite were examined using
I CTEM, and the following results were

(1) HREM images of ulexite were successfully ob-
served by using very low electron dose technique.

(2) Each grain with the size of 10 μm is composed
of single crystal plates which pile up in the grain with
a small misorientation.

(3) There is a preferable contact angle between two
grains at the interface. The experimental results are in
good agreement with the simulated results, which indi-
cates the degree of coincidence of the lattice developed
the strength of the high-angle grain boundary.

(4) Cleavage planes were determined as (010)
in ulexite and stacking faults are also introduced in
the plane.

(5) There are a number of small-angle grain bound-
aries with the misorientation angles between 3 and 11°.

(6) Light transmittance would depend on the micro-
structural characteristic, such as stacking faults and the
small-angle grain boundaries.

REFERENCES

1. N. Kreidl, Ceram. Bull. 63, 1394 (1984).
2. M. A. Saifi, S. J. Jong, L. G. Cohen, and J. Stone, Opt. Lett. 7, 43 (1982).
3. H. Etzkorn and W. E. Heinlein, Electron. Lett. 20, 423 (1984).
4. E. Maekawa and S. Sumida, J. Lightwave Technol. Lett. 3, 829 (1985).
5. J. Murdoch, Am. Mineral. 25, 754 (1940).
6. E. J. Weichel-Moore and R. J. Potter, Nature 200, 1163 (1963).
7. G. S. Baur and L. B. Sand, Am. Mineral. 42, 676 (1957).
8. J. R. Clark and C. L. Christ, Am. Mineral. 44, 712 (1959).
9. J. R. Clark and D. E. Appleman, Science 145, 1295 (1964).
10. L. Stoch and I. Waclawska, J. Therm. Anal. 36, 2045 (1990).
11. C. L. Christ, Am. Mineral. 45, 334 (1960).
12. C. L. Christ and J. R. Clark, Phys. Chem. Minerals 2, 59 (1977).
13. S. Ghose, C. Wan, and J. R. Clark, Am. Mineral. 63, 160 (1978).
14. S. Sueno, H. Takeda, and R. Sadanaga, Mineral. J. 6, 172 (1971).
15. Z. Inoue, Y. Uemura, and Y. Inomata, J. Mater. Sci. 16, 2297 (1981).
16. Y. Uemura, Y. Inomata, and Z. Inoue, J. Mater. Sci. 16, 2333 (1981).